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SPIDER (ARANEAE) TAXA ASSOCIATED WITH *MANTISPA VIRIDIS* (NEUROPTERA: MANTISPIDAE)

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ABSTRACT. Egg sacs of 25 species of spiders in 14 families were found to contain immatures of *Mantispa viridis* in northwestern South Carolina, bringing the total spider taxa associated with this species to at least 29 species in 15 families. Thirty-one of the 124 *M. viridis* infested egg sacs had two or more mantispids in them. However, only three of these sacs produced two or more adult mantispids, with two sacs producing two adults each and the third sac producing four adults.

Larvae of *Mantispa viridis* Walker, a member of the mantispid subfamily Mantispinae, are predators of spider eggs. First instars of *M. viridis* locate spider egg sacs and penetrate through the surrounding silk to gain access to the eggs, whereupon they develop through two additional and relatively immobile instars prior to pupation within the sac (Richardson 1976; Redborg & MacLeod 1985). Ten species of spiders in the families Agelenidae, Araneidae, Clubionidae, Ctenidae, Lycosidae, Theridiidae, and either the Clubionidae or Gnaphosidae have been associated with *M. viridis* (Milliron 1940; Stein 1955; Parfin 1958; Valerio 1971; Tolbert 1976; Hieber 1984; Redborg & MacLeod 1985; Roble 1986; Hoffman & Brushwein 1992).

In the first reported rearing of mantispine larvae, Brauer (1869) noted that although more than one first instar of the European *Mantispa styriaca* (Poda) would enter single egg sacs in the laboratory, only one would develop to the adult. Later, three to eight larvae of *Eumantispa harmandi* (Navás) were reported developing inside single egg sacs, although no information was given on larval survival or adult emergence (Kishida 1929; K. Kishida, pers. comm. in Bristowe 1932). Subsequent studies have documented the emergences of from two to seven adult mantispids from single egg sacs (McKeown & Mincham 1948; Downes 1985; Monserrat & Díaz-Aranda 1989), including *M. viridis* (Parfin 1958; Richardson 1976; W. W. Tolbert, pers. comm. in Richardson 1976).

Previous studies on *M. viridis* indicate that this species feeds on eggs of a broad taxonomic and ecological range of spiders and that more than one larva can successfully develop inside single egg sacs. The present paper reports the results of field studies conducted from 1982 through 1986 to document the spider taxa exploited by *M. viridis* in northwestern South Carolina, to determine the frequency with which multiple larvae attack single egg sacs, and to determine the number of adults which successfully develop in such multiply-infested sacs.

METHODS

Spider egg sacs and associated female spiders were collected from 1982 through 1986 by visual searching in various habitats within a 20 km radius of Clemson, South Carolina. The most frequently searched locations were wooded areas bordering Lake Hartwell and fields along South Carolina State Highway 123. Microhabitats sampled included foliage of hardwoods and conifers, ornamental shrubs, herbaceous vegetation, beneath tree bark, on the surface of the ground, under stones and fallen logs, in burrows of *Geolycosa* sp. (Lycosidae), and the outside surfaces of various buildings. All egg sacs located during these searches were collected. Egg sacs were opened in the laboratory and examined with a stereomicroscope. Sacs with mantispids inside were retained and the number of larvae and cocoons present were recorded, and those without

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Table 1.—Spider taxa associated with the immature stages of *Mantispa viridis* Walker. Taxa are arranged alphabetically, and incorporate taxonomic changes compiled by Platnick (1989) and Dondale and Redner (1990).

Family	Genus and species	Reference
Agelenidae	*Agelenopsis* sp., prob. *pennsylvanica* (C. L. Koch)	Parfin 1958
	Agelenopsis sp.	this report
Anyphaenidae	*Teudis mordax* (O. P.-Cambridge)	this report
Araneidae	*Araneus pegnia* (Walckenaer)	this report
	Araniella displicata (Hentz)	this report
	Argiope aurantia Lucas	Tolbert 1976, this report
	Argiope trifasciata (Forskål)	Tolbert 1976
	Cyclosa turbinata (Walckenaer)	this report
	Cyclosa sp., prob. *turbinata*	this report
	Metepeira labyrinthea (Hentz)	this report
	Neoscona arabesca (Walckenaer)	this report
	unidentified genus, prob. *Neoscona*	this report
Clubionidae	*Cheiracanthium inclusum* (Hentz)	this report
	Clubiona sp.	Hoffman and Brushwein 1992
Clubionidae or Gnaphosidae, undetermined		Stein 1955
Corinnidae	*Castianeira* sp.	this report
Ctenidae	*Cupiennius salei* (Keyserling)	Milliron 1940
Lycosidae	*Gladicosa pulchra* (Keyserling)	Roble 1986
	Varacosa avara (Keyserling)	Hoffman and Brushwein 1992
	unidentified genus	this report
Oxyopidae	*Peucetia viridans* (Hentz)	Fink 1968, 1987, this report
Philodromidae	*Philodromus imbecillus* Keyserling	this report
Pisauridae	*Pisaurina mira* (Walckenaer)	this report
Salticidae	*Habronattus coecatus* (Hentz)	this report
	Phidippus clarus Keyserling	this report
	Phidippus mystaceus (Hentz)	this report
	Plexippus paykulli (Audouin)	this report
Tetragnathidae	*Tetragnatha* sp.	this report
Theridiidae	*Achaearanea rupicola* (Emerton)	this report
	Achaearanea tepidariorum (C. L. Koch)	Valerio 1971, this report
	Latrodectus mactans (Fabricius)	this report
Thomisidae	*Misumenoides formosipes* (Walckenaer)	this report
	Tmarus angulatus (Walckenaer)	this report
Uloboridae	*Uloborus glomosus* (Walckenaer)	this report

mantispids were discarded. The numbers and identities of uninfested sacs were not recorded, but an estimated 350–700 egg sacs were examined during the course of the study. Egg sacs with larvae were placed in larval rearing cells while mantispid cocoons were placed in vials designed for maintaining adult mantispids. Rearing containers and environmental conditions were as described by Brushwein & Culin (1991). First instars of *M. viridis* were identified by the dorsal banding pattern on the thorax and abdomen, and second and third instars were identified by the characteristic shapes of the thoracic legs and tenth abdominal segments of each instar (Hoffman & Brushwein 1992).

In cases where field-collected egg sacs which contained mantispids were not associated with female spiders but still contained viable eggs or spiderlings, surviving spiders were reared to maturity on a variety of larval Lepidoptera and adult Diptera. Rearing conditions and procedures were the same as those used to maintain adult mantispids (Brushwein & Culin 1991). Spiders were identified by using the keys of Kaston (1948, 1978) and Roth (1985) and by comparison with previously identified specimens in the Clemson University Arthropod Collection (CUAC), Department of Entomology. Voucher specimens of immature and adult mantispids and the associated spiders are deposited in the CUAC.

Table 2.—Incidence and magnitude of multiple infestations of single spider egg sacs by *M. viridis* immatures and the maximum number of adult mantispids reared per sac.

Family	Genus and species	Number of sacs infested	Number of sacs with >1	Maximum number inside sac	Maximum number of adults
Agelenidae	*Agelenopsis* sp.	58	21	16	1
Araneidae	*Argiope aurantia* Lucas	4	1	5	1
	Metepeira labyrinthea (Hentz)	21	3	2	1
	Neoscona arabesca (Walckenaer)	1	1	2	1
	unidentified, prob. *Neoscona*	1	1	4	4
Pisauridae	*Pisaurina mira* (Walckenaer)	3	1	2	2
Salticidae	*Phidippus clarus* Keyserling	9	1	3	1
Theridiidae	*Latrodectus mactans* (Fabricius)	6	2	2	2

RESULTS AND DISCUSSION

Egg sacs of 124 spiders contained immatures of *M. viridis* in the Clemson area. These spiders belonged to 25 species in 23 genera representing 14 families, bringing the total spider taxa associated with *M. viridis* to at least 29 species in 26 genera from 15 families (Table 1). Three of the species were previously associated with *M. viridis* and 20 are newly associated, while the status of the unidentified species of *Agelenopsis* and of Lycosidae as previously or newly associated taxa can not be clarified in the absence of species-level identifications. Eight species had more than one egg sac associated with *M. viridis*. Six of these eight species had at least one egg sac infested with two or more immatures and are listed in Table 2. The other two species were the unidentified *Cyclosa* species with two singly-infested egg sacs in a single web and *Peucetia viridans* (Hentz) with two singly-infested sacs.

Egg sacs containing more than one *M. viridis* larva were relatively common and accounted for 25% (31 of 124) of the total number of infested sacs (Table 2). However, multiple adults were reared from only 9.7% (3 of 31) of the multiply-infested sacs. Also, although as many as 16 immatures were found inside single sacs, no more than four developed into adults from any one sac. Failure of larvae to develop in multiply-infested sacs was most likely due to either starvation or intraspecific aggression. First instars become relatively immobile shortly after feeding commences and second and third instars possess very reduced legs. Therefore, developing larvae are trapped inside egg sacs and are vulnerable to starvation if the available eggs are depleted by other larvae. Multiple adults of *M. viridis* were able to develop in single egg sacs of *Pisaurina mira* (Walckenaer), *Latrodectus mactans* (Fabricius), and an unidentified large araneid, possibly because the spiders are relatively large and produce large egg sacs. Mortality caused by conspecifics also may play a role in multiply-infested sacs. Richardson (1976) noted that it was not uncommon for second and third instars of *M. viridis* to kill other larvae when reared together in the laboratory. Unfortunately, many of the larvae in multiply-infested sacs in the present study were already dead and somewhat dessicated when the sacs were first examined, making a conclusive determination of the cause of their fate impossible.

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